Amendments to the Claims

Please cancel claims 1695, 1714, and 1733 without prejudice.

The following listing of claims will replace all prior versions and/or listings of claims in the application:

Listing of Claims:

1-1690. (cancelled)

1691. (previously presented): A system configured to heat a hydrocarbon containing formation, comprising:

a heater well extending from a surface of the earth through an overburden of the formation and into a hydrocarbon containing layer in the formation;

an AC supply configured to provide AC at a frequency between about 100 Hz and about 1000 Hz;

one or more electrical conductors located in the heater well, at least one of the electrical conductors extending from the surface into the hydrocarbon containing layer, and at least one of the electrical conductors being electrically coupled to the AC supply;

at least one electrical conductor comprising an electrically resistive ferromagnetic material, the electrical conductor being configured to provide an electrically resistive heat output during application of AC to the electrical conductor, and the electrical conductor being configured to provide a reduced amount of heat above or near a selected temperature, the selected temperature being within about 50 °C of the Curie temperature of the ferromagnetic material; and

wherein the system is configured to provide heat to the hydrocarbon containing formation such that sufficient heat transfers from at least one of the electrical conductors to hydrocarbons in the hydrocarbon containing formation to at least mobilize some hydrocarbons in the formation.

1692. (previously presented): The system of claim 1691, further comprising at least one production well extending into the hydrocarbon containing layer and configured to produce at least some of the mobilized hydrocarbons from the hydrocarbon containing layer.

1693. (previously presented): The system of claim 1691, wherein at least one electrical conductor transfers heat during use to hydrocarbons in the hydrocarbon containing layer to at least mobilize some hydrocarbons in the layer.

1694. (previously presented): The system of claim 1691, wherein at least one electrical conductor transfers heat during use to hydrocarbons in the hydrocarbon containing layer to pyrolyze at least some hydrocarbons in the layer.

1695. (cancelled)

1696. (previously presented): The system of claim 1691, wherein at least one of the ferromagnetic sections heats during use to a temperature of at least about 650 °C.

1697. (previously presented): The system of claim 1691, wherein the AC supply is coupled to a supply of line current, and wherein the AC supply is configured to provide AC at about three times the frequency of the line current.

1698. (previously presented): The system of claim 1691, wherein the AC supply is configured to provide AC with a frequency between about 140 Hz and about 200 Hz.

1699. (previously presented): The system of claim 1691, wherein AC supply is configured to provide AC with a frequency between about 400 Hz and about 550 Hz.

1700. (previously presented): The system of claim 1691, wherein the ferromagnetic material comprises iron, nickel, chromium, cobalt, tungsten, or a mixture thereof.

1701. (previously presented): The system of claim 1691, wherein a thickness of the ferromagnetic material is at least about ¾ of a skin depth of the AC at the Curie temperature of the ferromagnetic material.

1702. (previously presented): The system of claim 1691, wherein the heat output below the selected temperature is greater than about 400 watts per meter of the electrical conductor.

1703. (previously presented): The system of claim 1691, wherein at least a portion of at least one of the electrical conductors is longer than about 10 m.

1704. (previously presented): The system of claim 1691, wherein the system is configured to sharply reduce the heat output at or near the selected temperature.

1705. (previously presented): The system of claim 1691, wherein the system is configured such that the heat output of at least a portion of the system decreases at or near the selected temperature due to the Curie effect.

1706. (previously presented): The system of claim 1691, wherein the system is configured to apply AC of at least about 70 amps to at least one of the electrically resistive sections.

1707. (previously presented): The system of claim 1691, wherein at least one of the electrical conductors comprises a turndown ratio of at least about 2 to 1.

1708. (previously presented): The system of claim 1691, wherein the system is configured to withstand operating temperatures of about 250 °C or above.

1709. (previously presented): The system of claim 1691, wherein the electrical conductor is configured to automatically provide the reduced amount of heat above or near the selected temperature.

1710. (previously presented): A system configured to heat a hydrocarbon containing formation, comprising:

a heater well extending from a surface of the earth through an overburden of the formation and into a hydrocarbon containing layer in the formation;

an AC supply configured to provide AC at a frequency between about 100 Hz and about 1000 Hz;

one or more electrical conductors located in the heater well, at least one of the electrical conductors extending from the surface into the hydrocarbon containing layer, and at least one of the electrical conductors being electrically coupled to the AC supply;

at least one electrical conductor comprising an electrically resistive ferromagnetic material, the electrical conductor being configured to provide an electrically resistive heat output during application of AC to the electrical conductor, and the electrical conductor being configured to provide a reduced amount of heat above or near a selected temperature that is about 20% or less of the heat output at about 50 °C below the selected temperature, and wherein the selected temperature is at or about the Curie temperature of the ferromagnetic material; and

wherein the system is configured to provide heat to the hydrocarbon containing formation such that sufficient heat transfers from at least one of the electrical conductors to hydrocarbons in the hydrocarbon containing formation to at least mobilize some hydrocarbons in the formation.

1711. (previously presented): The system of claim 1710, further comprising at least one production well extending into the hydrocarbon containing layer and configured to produce at least some of the mobilized hydrocarbons from the hydrocarbon containing layer.

1712. (previously presented): The system of claim 1710, wherein at least one electrical conductor transfers heat during use to hydrocarbons in the hydrocarbon containing layer to at least mobilize some hydrocarbons in the layer.

1713. (previously presented): The system of claim 1710, wherein at least one electrical conductor transfers heat during use to hydrocarbons in the hydrocarbon containing layer to pyrolyze at least some hydrocarbons in the layer.

1714. (cancelled)

1715. (previously presented): The system of claim 1710, wherein at least one of the ferromagnetic sections heats during use to a temperature of at least about 650 °C.

1716. (previously presented): The system of claim 1710, wherein the AC supply is coupled to a supply of line current, and wherein the AC supply is configured to provide AC at about three times the frequency of the line current.

1717. (previously presented): The system of claim 1710, wherein the AC supply is configured to provide AC with a frequency between about 140 Hz and about 200 Hz.

1718. (previously presented): The system of claim 1710, wherein AC supply is configured to provide AC with a frequency between about 400 Hz and about 550 Hz.

1719. (previously presented): The system of claim 1710, wherein the ferromagnetic material comprises iron, nickel, chromium, cobalt, tungsten, or a mixture thereof.

1720. (previously presented): The system of claim 1710, wherein a thickness of the ferromagnetic material is at least about ¾ of a skin depth of the AC at the Curie temperature of the ferromagnetic material.

1721. (previously presented): The system of claim 1710, wherein the heat output below the selected temperature is greater than about 400 watts per meter of the electrical conductor.

1722. (previously presented): The system of claim 1710, wherein at least a portion of at least one of the electrical conductors is longer than about 10 m.

1723. (previously presented): The system of claim 1710, wherein the system is configured to sharply reduce the heat output at or near the selected temperature.

1724. (previously presented): The system of claim 1710, wherein the system is configured such that the heat output of at least a portion of the system decreases at or near the selected temperature due to the Curie effect.

1725. (previously presented): The system of claim 1710, wherein the system is configured to apply AC of at least about 70 amps to at least one of the electrically resistive sections.

1726. (previously presented): The system of claim 1710, wherein at least one of the electrical conductors comprises a turndown ratio of at least about 2 to 1.

1727. (previously presented): The system of claim 1710, wherein the system is configured to withstand operating temperatures of about 250 °C or above.

1728. (previously presented): The system of claim 1710, wherein the electrical conductor is configured to automatically provide the reduced amount of heat above or near the selected temperature.

1729. (previously presented): A method of heating a hydrocarbon containing formation, comprising:

providing AC at a frequency between about 100 Hz and about 1000 Hz to one or more electrical conductors located in a heater well extending from a surface of the earth through an overburden of the formation and into a hydrocarbon containing layer in the formation, wherein providing the AC produces an electrically resistive heat output from the electrical conductors, at least one of the electrical conductors comprising one or more electrically resistive ferromagnetic sections;

wherein one or more of the electrically resistive ferromagnetic sections are configured to provide a reduced amount of heat above or near a selected temperature, the selected temperature being within about 50 °C of the Curie temperature of the ferromagnetic material; and

allowing heat to transfer from the electrical conductors to hydrocarbons in the hydrocarbon containing layer to at least mobilize some hydrocarbons in the layer.

1730. (previously presented): The method of claim 1729, further comprising producing at least some of the mobilized hydrocarbons from the layer through a production well extending into the hydrocarbon containing layer.

1731. (previously presented): The method of claim 1729, wherein the transferred heat pyrolyzes at least some hydrocarbons in the hydrocarbon containing layer.

1732. (previously presented): The method of claim 1731, further comprising producing at least some of the pyrolyzed hydrocarbons from the layer through a production well extending into the hydrocarbon containing layer.

1733. (cancelled)

1734. (previously presented): The method of claim 1729, wherein at least one of the ferromagnetic sections heats to a temperature of at least about 650 °C.

1735. (previously presented): The method of claim 1729, further comprising providing an initial electrically resistive heat output when the electrical conductor providing the heat output is at least about 50 °C below the selected temperature, and automatically providing the reduced amount of heat above or near the selected temperature.

1736. (previously presented): The method of claim 1729, further comprising providing the AC at about three times the frequency of line current from an AC supply.

1737. (previously presented): The method of claim 1729, further comprising providing the AC at a frequency between about 140 Hz and about 200 Hz.

1738. (previously presented): The method of claim 1729, further comprising providing the AC at a frequency between about 400 Hz and about 550 Hz.

1739. (previously presented): The method of claim 1729, wherein a thickness of at least one of the ferromagnetic sections is at least about ¾ of a skin depth of the AC at the Curie temperature of the ferromagnetic material.

1740. (previously presented): The method of claim 1729, further comprising providing a reduced amount of heat above or near the selected temperature of less than about 400 watts per meter of length of the electrical conductor.

1741. (previously presented): The method of claim 1729, further comprising controlling a skin depth in the electrical conductor by controlling a frequency of the AC applied to the electrical conductor.

1742. (previously presented): The method of claim 1729, further comprising controlling the amount of current applied to the electrical conductors to control an amount of heat provided by at least one of the electrically resistive sections.

1743. (previously presented): The method of claim 1729, further comprising applying current of at least about 70 amps to the electrical conductor.

1744. (previously presented): The system of claim 1691, wherein the heater well extends at least about 10 m into the hydrocarbon containing layer.

1745. (previously presented): The system of claim 1691, wherein the hydrocarbon containing layer comprises hydrocarbons configured to be treated and produced from the formation using an in situ conversion process.

1746. (previously presented): The system of claim 1710, wherein the heater well extends at least about 10 m into the hydrocarbon containing layer.

1747. (previously presented): The system of claim 1710, wherein the hydrocarbon containing layer comprises hydrocarbons configured to be treated and produced from the formation using an in situ conversion process.

1748. (previously presented): The method of claim 1729, wherein the heater well extends at least about 10 m into the hydrocarbon containing layer.

1749. (previously presented): The method of claim 1729, wherein the hydrocarbon containing layer comprises hydrocarbons configured to be treated and produced from the formation using an in situ conversion process.